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Prevalence of *Streptococcus pneumoniae* in Respiratory Samples from Patients with Tracheostomy in a Long-Term-Care Facility

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We aimed to study the prevalence of *Streptococcus pneumoniae* in respiratory samples from institutionalized patients with chronic tracheostomy. A total of 264 pairs of nasopharyngeal and endotracheal cultures were collected. There was no difference in the proportion of positive cultures between children (21%) and adults (18%). However, the proportion of positive endotracheal cultures was higher than that of nasopharyngeal cultures in adults (18% versus 3%, respectively; $P < 0.001$) but not in children (17% in both sites).

Infection with *Streptococcus pneumoniae* can result in a range of illnesses, including bacteremia, meningitis, pneumonia, otitis media, and sinusitis, which together cause substantial morbidity and mortality worldwide (7). *S. pneumoniae* gains entry into the host by colonizing the nasopharyngeal (NP) mucosal epithelium. Although colonization at this site is usually asymptomatic, if the organism gains access to the normally sterile parts of the airway a rapid inflammatory response ensues, resulting in disease (6, 7). The colonization rate is much higher in young children than in adults (8) and is influenced by a variety of factors, including geographic location, season, overcrowding, and day care attendance (6). There is a paucity of data regarding the presence of *S. pneumoniae* in the lower respiratory tract (LRT) of individuals without acute infection. The data suggest that *S. pneumoniae* is absent in the airways of healthy individuals (4) or in children with recurrent wheezing (9), but it can be detected in a small proportion (7%) of patients with chronic obstructive pulmonary disease (COPD) (4). An epidemiologically distinct subpopulation among patients with chronic respiratory disorders comprises those with chronic tracheostomy tubes. In these patients, bacterial LRT colonization almost always follows tracheal intubation (3). Two studies reported a prevalence of *S. pneumoniae* in LRT cultures in chronic tracheostomy patients of 8% (4) and 42% (3). However, these studies were conducted on a small number of patients and did not include a concurrent assessment of the nasopharyngeal carriage rate. The aims of the present study were to study the prevalence of *S. pneumoniae* in respiratory samples of patients with chronic tracheostomy, to compare the carriage rates found in NP versus endotracheal (ET) cultures, and to assess the effects of demographic and microbiologic variables on the site of isolation.

The Reuth Medical Center in Tel Aviv is a 300-bed, long-term-care facility (250 adults, 50 children) with patients divided into the following wards: chronically ventilated (adult and pediatric), rehabilitation, and skilled nursing care. The study was conducted in the context of an intervention initiated by the National Center for Infection Control to investigate the prevalence of fluoroquinolone-resistant *S. pneumoniae* in clinical cultures at the facility (10). A point prevalence surveillance study of *S. pneumoniae* colonization was conducted first in January 2009 followed by two follow-up surveys in December 2009 to January 2010 and May to June 2011. Respiratory tract *S. pneumoniae* colonization of patients with chronic tracheostomy tubes was tested by NP and ET sampling. Patients were not presumed to have acute respiratory infection. Only patients who had both samples collected simultaneously were included in the analysis. NP cultures were collected using the Transwab Pernasal Amies plain wire swabs (Medical Wire, Corsham, United Kingdom), and ET aspirates were obtained using a suction catheter introduced through the tracheostomy tube. Specimens were streaked onto either tryptic soy agar with 5% sheep blood and gentamicin (5 mg/liter) (1st and 2nd surveys) or streptococcal select agar plates (Hy-labs, Rehovot, Israel) (3rd survey) and incubated overnight at 37°C in 5% CO_2; these two media have shown the ability to support the growth of *S. pneumoniae* equivalent to that of tryptic soy agar-5% sheep blood (data not shown). Pneumococcal identification and antimicrobial susceptibility testing were performed by the Vitek-2 system on the GP and AST-GP68 cards (bioMérieux, Marcy l'Etoile, France), respectively. Susceptibility was determined using the breakpoint criteria of the Clinical and Laboratory Standards Institute (CLSI) (5). Determination of capsular serotypes was performed as previously described (1). The rates of NP- versus ET-derived positive cultures were compared using McNemar's test, and correlations between categorical variables (including age groups) were analyzed using the χ^2 test. All analyses were performed using the Statistical Package for the Social Sciences (SPSS for Windows, version 15.0, Inc.). The study was approved by the Ethics Committee of the Tel Aviv Sourasky Medical Center.

In the three surveys conducted, 264 pairs of NP and ET cultures were taken from 188 patients; 130, 40, and 18 patients were sampled once, twice, and thrice, respectively. The mean and median ages of patients were 55 (standard deviation [SD], 28 years) and 60 years old, respectively, ranging from 2 to 103 years. There were 30, 21, and 7 patients younger than 18, 6, and 3 years of age, respec-

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TABLE 1 Source and timing of *S. pneumoniae* surveillance cultures

Isolate type[a]	Positive samples, no. (%)	*P* value[b]
1st survey		
Total ($n = 61$)	13 (21)	<0.05
NP	1	
ET	9	
NP+ET	3	
2nd survey		
Total ($n = 95$)	12 (12)	<0.05
NP	1	
ET	9	
NP+ET	2	
3rd survey		
Total ($n = 108$)	25 (23)	<0.01
NP	3	
ET	18	
NP+ET	4	
All surveys		
Total ($n = 264$)	50[c] (19)	<0.001
NP	5	
ET	36	
NP+ET	9	
Any NP	14 (5)	
Any ET	45 (17)	

[a] NP, isolation in nasopharyngeal sample alone; ET, isolation in endotracheal sample alone; NP+ET, isolation in both samples.
[b] McNemar's test, comparing the rates of *S. pneumoniae*-positive cultures in all ET versus NP cultures.
[c] Number of patient-unique isolates: NP, 5; ET, 34; NP+ET, 8.

TABLE 2 Microbiological characteristics of *S. pneumoniae* isolates from 264 samples taken from 188 patients who underwent both nasopharyngeal and endotracheal sampling

Characteristic	No. (%) with characteristic[a]				*P* value[b]
	NP	ET	NP+ET	Total	
Positive samples	5 (10)	36 (72)	9 (18)	50	
Serotype[c]					<0.05
15A	1 (20)	2 (40)	2 (40)	5	
17F	2 (28)	5 (72)	0	7	
19F[d]	1 (8)	9 (69)	3 (23)	13	
23F[d]	1 (5)	17 (85)	2 (10)	20	
Penicillin nonsusceptible	3 (9)	26 (72)	7 (19)	36	NS[e]
Cefotaxime nonsusceptible	0	7 (87)	1 (13)	8	NS
Ofloxacin nonsusceptible	2 (6)	26 (76)	6 (18)	34	NS

[a] NP, isolation in nasopharyngeal sample alone; ET, isolation in endotracheal sample alone; NP+ET, isolation in both samples.
[b] χ^2 test was used for all analyses.
[c] Additional serotypes: 15B ($n = 1$, NP culture), 6A ($n = 2$, NP and ET cultures), nontypeable ($n = 3$, ET culture).
[d] Two *S. pneumoniae* serotypes, 19F and 23F from NP and ET cultures, respectively, were isolated in a single patient.
[e] NS, not significant.

tively. Ninety-nine patients (53%) were male, and 89 (47%) were female. The number of *S. pneumoniae*-positive cultures according to culture site and survey is presented in Table 1. The numbers of positive NP and ET cultures were 14 (5%) and 45 (17%), respectively ($P < 0.001$), and the proportion of positive results was significantly higher in ET than in NP cultures in all 3 surveys. Of the 188 patients, 44 (23%) had positive samples at least once; 6 of these had positive samples twice, but no patient had 3 positive samples. There was no significant difference in the overall proportion of positive cultures or the distribution of positive culture sites between the 3 surveys. There was no significant difference in the gender distribution between patients with ET- and NP-derived positive cultures or in the overall proportion of positive cultures in children (≤18 years old) versus adults (21% versus 18%, respectively; $P > 0.05$). However, the ratios of positive NP, ET, and NP plus ET cultures were 3/10, 3/10, and 4/10, respectively, in children versus 2/40, 33/40, and 5/40, respectively, in adults ($P < 0.05$). Hence, the proportion of positive ET cultures was higher than that for NP cultures in adults (18% versus 3%, respectively; $P < 0.001$) but the proportions were comparable in children (17% in both groups; $P = 1$).

The microbiological characteristics of the isolates according to isolation site are presented in Table 2. Serotypes 19F and 23F were more common in adults than children (72% versus 30%, respectively), whereas serotypes 15A and 17F were more common among children than adults (70% versus 12%, respectively) ($P < 0.01$ for the overall distribution of serotypes by age groups). Consequently, serotype 23F was more common in ET-derived isolates (ET, 42%; NP, 21%), whereas 15A was more common in NP-derived isolates (ET, 9%; NP, 21%). The proportions of serotypes 17F and 19F were similar in both groups. The majority of isolates were nonsusceptible to penicillin (72%) and ofloxacin (68%), with 18% nonsusceptibility to cefotaxime. Resistance to ofloxacin was more common in adults than in children (31/40 versus 3/10; $P = 0.004$). This was related to the high frequency of ofloxacin resistance in serotypes 19F (92%) and 23F (100%) compared with that in other serotypes (14%).

The present study is the first to compare the prevalence of *S. pneumoniae* in ET versus NP cultures in patients with tracheostomy. A 3% prevalence was found in NP cultures in adults, similar to the prevalence in healthy adults (8). Surprisingly, the prevalence in ET cultures was significantly higher. From the limited data available, it seems that *S. pneumoniae* is absent from the LRT of healthy individuals (4) but may be found in patients with chronic respiratory diseases, such as COPD (4), or those with chronic tracheostomy (3). The LRT in patients with tracheostomy is frequently colonized with multiple organisms, including Gram-negative rods (2, 3), as was also observed in our study (data not shown). Hence, clinical interpretation of our findings may be difficult, as the distinction between colonizing and pathogenic organisms may not be clear. It is possible that quantitative cultures will allow better understanding of the roles of the various organisms during episodes of clinical exacerbation (2).

The prevalence of *S. pneumoniae* in NP cultures in children (17%) was lower than that reported in other studies (6, 8). This can be explained by the fact that most of the children in our study (86%) were older than 2 years of age. Unlike the findings in adults, in children the prevalence of *S. pneumoniae* was identical in NP and ET cultures. We also observed differences between adults and children in predominant serotype populations. Serotypes 19F and 23F, which were mostly resistant to ofloxacin, were more common in adults, in contrast to findings from a previous study from Israel (8). As most children were hospitalized in separate wards, this

suggests a role for local dissemination of these strains in the respective wards rather than age- or site (NP versus ET)-specific predilection. In summary, our study demonstrated a high prevalence of *S. pneumoniae* in the LRT of patients with chronic tracheostomy. Further studies are required to establish this finding in different locations and to explore the host-pathogen interactions and modes of dissemination of *S. pneumoniae* in these patients.

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